Chapter 3
Problem Status

"Earlier, I didn't understand why I got no answer to my question, today I don't understand how I presumed to ask a question. But then I didn't presume, I only asked" Franz Kafka—the Zurau Aphorisms.

Abstract A major problem for researchers, analysts, forecasters and, indeed, investors is to identify how, when, and where new events and trends will play out. In essence most problems have multiple numbers of variables, and where each variable has a number of conditions or dimensions. So, how can we address the outcomes of futures governed by such complexity? This chapter introduces the notion that problems come in various shapes and sizes which can be best addressed via a set of techniques known as Problem Structuring Methods (PSMs). Once the problem characteristic has been identified (is it a puzzle, a causal problem, or a wicked problem?), then the problem can be positioned within the Uncertainty matrix so the most appropriate PSM can be applied. This positioning also allows the analyst to explore issues such as decision stakes and systems uncertainties. The chapter ends by introducing Rosenhead's Robustness Analysis method as an appropriate MTT for addressing the early stages of problem identification.

Keywords Puzzle · Causal problem · Wicked problem · Mess · Tame problem · Unintended consequences · Problem structuring method · Post normal · Robustness analysis

3.1 Introduction: What Is the Problem?

Problems can come in different shapes and sizes. Analysts and decision makers are often too impatient with trying to solve the problem—without understanding the problem's true nature So, how can we clarify this true nature as failure to do so can lead us down sub-optimum paths possessing any number of unintended consequences?

> . . .the most demanding and troubling task in formative decision situations is to decide what the problem is. There are too many factors; many of the relationships between them are

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unclear or in dispute; the most important do not reduce naturally to quantified form; different stakeholders have different priorities (Rosenhead & Mingers, 2001).

The space which the problem occupies is called, naturally enough, a **problem spa**ce—the latter being a mental representation of the mix of variables and their respective conditions relating to a particular problem. Problem spaces do not necessarily contain any details of the solution of what is important, as one must not make any assumptions about a solution too early and thus eliminate viable possibilities. And, as we shall see in Chap. 9, we need to allow for a whole array of biases to play out, particularly at an early stage when the problem is still being articulated.

Apart from identifying and tracking different groups of variables, an additional concern is to ascertain where specific topics (e.g. technologies), might be in relation to a time horizon—now, next year, within 5 years, 20 years, the distant future, or even never—the When or Temporal driver (more on this in Chap. 4). This chapter lays out the main boundaries to help different stakeholders address the range and scope of the problem and its current and new event impacts.

Of additional concern however, is the sheer scale of what different events might occur. More crucially is the requirement to identify not only core sectors but their rate of development, what are the visible trends as well as hidden, outlier trends.

One category of Decision Support Methods (DSMs), **Problem Structuring Methods (PSMs)** is particularly applicable to supporting decision-making under uncertainty. In the latter part of this chapter—the section on methods, tools, and techniques (MTTs), a more detailed description of PSMs is presented, particularly by its main advocates Jonathan Rosenhead and John Mingers. The chapter ends with a run-through of a little-known method developed by Rosenhead, "Robustness Analysis", which I urge readers to explore further.

Simon (1977) states that the Decision-Making process can be broken down into three main stages:

- Intelligence: Fact finding, problem and opportunity sensing, analysis, and exploration.
- Design: Formulation of solutions, generation of alternatives, modelling and simulation.
- Choice: Goal maximisation, alternative selection, decision-making, and implementation.

Decision Support Methods (DSMs) thus fit well within the first of Simon's three stages and are represented by a body of models, tools, and processes which help to mitigate risk and provide greater clarity under conditions of uncertainty and where the intelligence ingredients may be rapidly changing and not easily specified in advance. PSMs are largely used where a problem is poorly defined or unstructured. Such methods were developed independently from the mid-1960s onwards by academics such as Stafford Beer (1984), Rittel and Webber (1973), Kunz and Rittel (1970), Ackoff (1961, 1974), and Nelson (1974). The area of thinking covered matters concerning systems thinking, including systems dynamics (Simon's second stage).

The very nature of unstructured problems would indicate that, such are the uncertainties inherent therein; no single methodology is likely to “solve” such a problem. Indeed, such a condition of initial ambiguity as to a defined outcome creates fuzziness, encouraging the introduction of assessing problems with more than one methodology—“multi-methodology”.

The inherent complexity of integrating current models and methods should not act as a deterrent since such complexity, although a challenge for practitioners, outweighs the dangers of using overly discrete methods to solve problems in the areas of uncertainty and risk. It may be that concepts such as “Fuzzy Management”, which recognises that we live in an occluded world, can help smooth the route from theory into performance enhancing practice (Grint, 1997). **It is often better to be approximately right than precisely wrong!**

Such complexity is a problem for practitioners of all shades. The problem is that no one method or tool is sufficiently robust to help the decision-making process when faced with uncertainty (and risk). Some of these methods are relatively easy to grasp, leading to wide adoption by numerous practitioners. Unfortunately, many of them only address part of the problem. When applied discretely they can appear to be over simplistic and not address the high levels of complexity, interconnectivity, and uncertainty inherent in the problem space. The situation is exacerbated exponentially when multiple criteria and parameters have to be addressed.

3.2 Problem Types: Not All Problems Are the Same

By understanding better, the nature of the problem, practitioners can improve their selection of the most appropriate method to help in their decision-making. If the problem is ill-defined or understood, then how can an appropriate method be selected and used to help overcome the problem?

Treverton (2010) notes that (analytic) problems vary from the simple to the highly complicated such that:

- ***A Puzzle***—is a well-defined and well-structured problem with clearly defined boundaries with one correct answer for a specific solution.
- A ***Problem*** (or tame problem)—has a defined form or structure; it is dimensioned; it has variables but it does not have any one, single, clear-cut solution and does have known probabilities, e.g. computer hacking, management of pricing and costs.
- ***A “Wicked Problem” or Mess***—is a complex issue with no defined boundaries. Such problems are highly unstructured (even unsolvable) with multiple actors and stakeholders, multiple perspectives, incommensurable and/or conflicting interests, and numerous intangibles. They do not have a single correct solution or even any solution as they do not provide any way of knowing when a solution has been reached.

This is very similar to the identification of problem type initially highlighted by the likes of Ackoff, Rittel, and Webber, Nelson, and Conklin. As ever the re-invention of the wheel.

It is this third category of problem that we shall be concentrating on in this chapter as such problems have their origins in heightened levels of uncertainty. However, before embarking on a more detailed explanation of Wicked Problems and Messes, it may be worth spending a little time expanding on understanding what is a standard or tame problem.

3.2.1 A Note About Tame Problems

Conklin (2006) identifies a "tame problem" as being one for which the traditional linear process is sufficient to produce a workable solution in an acceptable time frame. A tame problem:

- Has a well-defined and stable problem statement,
- Has a definite stopping point, i.e. when the solution is reached,
- Has a solution which can be objectively evaluated as right or wrong,
- Belongs to a class of similar problems which are all solved in the same similar way,
- Has solutions which can be easily tried and abandoned,
- Comes with a limited set of alternative solutions.

Conklin provides examples of tame problems such as finding the square root of 7358, finding the shortest route from A to B on a map, repairing a computer, raising money, and selecting a new doctor when moving to a new town. All these are tame, if complex and difficult, problems. Note that the concept "Tame", does not necessarily mean simplicity. In summary, for any given tame problem, an exhaustive formulation can be stated containing all the information the problem-solver needs for understanding and solving the problem.

3.2.2 Wicked Problems and Messes

In 1973, Horst Rittel and Melvin Webber in an article titled "Dilemmas in a General Theory of Planning" observed that there is a whole realm of social planning problems that cannot be successfully treated with traditional linear, analytical approaches. They called these **"wicked problems"** (in contrast to tame problems).

A year later in 1974, Russell Ackoff (1974), then at the LSE, in a book entitled "Re-designing the Future", independently came up with a similar concept which he called "a mess", later to become a "social mess".

Rittel and Weber identified 10 characteristics of a wicked problem.

- There is no definitive formulation of a wicked problem—You do not understand the problem until you have developed a solution. In order to describe a wicked problem in sufficient detail, one has to develop an exhaustive inventory of all conceivable solutions ahead of time. Therefore, in order to anticipate all questions (in order to anticipate all information required for resolution ahead of time), knowledge of all conceivable solutions is required. The formulation of a wicked problem is the problem!
- Wicked problems have no stopping rule—No stopping rule; since as there is no definitive "Problem", there is also no definitive "Solution".
- Solutions to wicked problems are not true-or-false, but good-or-bad—Solutions to wicked problems are not right or wrong but better or worse.
- There is no immediate and no ultimate test of a solution to a wicked problem—any solution, after being implemented, will generate waves of consequences over an extended—virtually an unbounded—period of time.
- Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly (every implemented solution is consequential. It leaves "traces" that cannot be undone)—as per Rittel and Webber.
- Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
- Every wicked problem is essentially unique—Every wicked problem is essentially unique and novel.
- Every wicked problem can be considered to be a symptom of another problem.
- The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution—Wicked problems have no given alternative solutions.
- The planner has no right to be wrong.

As identified above, in the year following Rittel's and Webber's treatise, Russell Ackoff developed a very similar interpretation of a wicked problem, within a framework encompassing an explanation of two other categories of problem (as opposed to just tame problems).

As per the initial three problem categories Ackoff's first version of a problem he calls a "puzzle". A puzzle is a well-defined and well-structured problem with a specific solution that can be worked out.

The next level Ackoff called a "problem" per se. This is an issue that does have a defined form or structure; it can have certain dimensions however and will contain a number of variables about which some information is available in addition as to how they may interact. Nonetheless there may not be a single easily identifiable solution. Indeed, there may be a variety of alternative solutions subject to different types of input such as what resources might be available, access to certain technologies, or what the political landscape might look like after an election. As we may not know these things yet, we have to leave the problem's solution open to different hypotheses about how the future might turn out (Ritchey, 2002).

Table 3.1 Comparing wicked and tame problems

Wicked problems vs tame problems	
Wicked problems	Tame problems
• There are many apparent causes of the problem that are inextricably tangled (in effect there is a high level of complexity).	• Has a well-defined and stable problem statement
• To describe a wicked problem in sufficient detail, requires one to develop an exhaustive inventory of all possible solutions ahead of time. The formulation of a wicked problem is the problem!	• Has a definite stopping point, i.e. when the solution is reached
• It is impossible to be sure when you have the correct or best solution.	• Has a solution which can be objectively evaluated as right or wrong
• Solutions to wicked problems are not right or wrong but better or worse.	• Belongs to a class of similar problems which are all solved in a similar way
• Any solution, after being implemented, will generate waves of consequences over an extended period of time.	• Has solutions which can be easily tried and abandoned
• There are multiple stakeholders with conflicting values and priorities.	• Comes with a limited set of alternative solutions.

Ackoff's equivalent of a "wicked" problem he defined as a "mess". A mess is a complex issue, which does not yet have a well-defined form or structure. When you have a mess, you do not even know with any certainty, what the problem is yet.

There is a tendency to treat problem structuring and problem resolution in isolation, as puzzles. The relationship between messes, problems, and puzzles is summed up succinctly by Michael Pidd (1996), stating:

> One of the greatest mistakes that can be made when dealing with a mess is to carve off part of the mess, treat it as a problem and then solve it as a puzzle—ignoring its links with other aspects of the mess.

Finally, Table 3.1 above illustrates the comparison between Wicked and Tame problems.

An empirical and visual approach to problem solving is presented by Conklin (2006) who compares traditional, linear (or "top down") approaches to problem solving with non-linear and dynamic situations. Conklin states that in the linear approach one begins by understanding the problem which can include gathering and analysing users' requirements. Once the problem has been specified and the requirements analysed, the designer or analyst is ready to formulate a solution, leading to implementation of that solution. He illustrates this pattern of problem solving as the "waterfall" approach (Fig. 3.1).

Yet this is an oversimplification of any problem-solving and design activity. Conklin states that even late into a creative process analysts and designers may have to return to problem definition and re-evaluate their understanding of said problem:

> Our experience in observing individuals and groups working on design and planning problems is that, indeed, their understanding of the problem continues to evolve—forever!

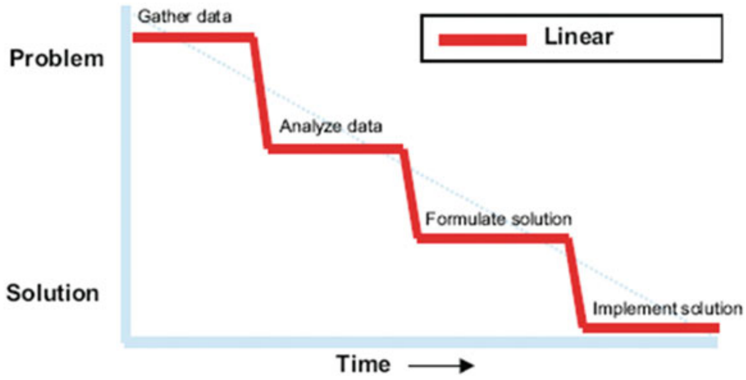

Fig. 3.1 Traditional wisdom for solving complex problems "the waterfall". (Conklin, 2006, p. 5)

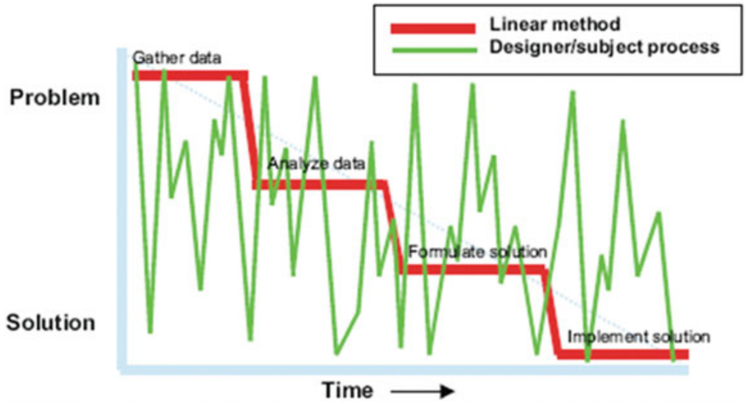

Fig. 3.2 Evolution of the problem

> Even well into the implementation of the design or plan, the understanding of the problem, the 'real issue,' is changing and growing.

Figure 3.2 this shows the observation that problem understanding continues to evolve until the very end of the experiment or project. Linearity provides little help in the way of guideline the practitioner through an iterative process

Finally, Conklin illustrates how even the highly irregular cognitive paths identified in Fig. 3.2, can be rendered more chaotic by the inclusion of an additional designer or, indeed any new stakeholder or stakeholders (as in Fig. 3.3)—as it can reflect, "a deeper order in the cognitive process" and where:

> The non-linear pattern of activity that expert designers go through gives us fresh insight into what is happening when we are working on a complex and novel problem. It reveals that the feeling that we are 'wandering all over' is not a mark of stupidity or lack of training. This non-linear process is not a defect, but rather the mark of an intelligent and creative learning process Conklin (2006) p. 1.

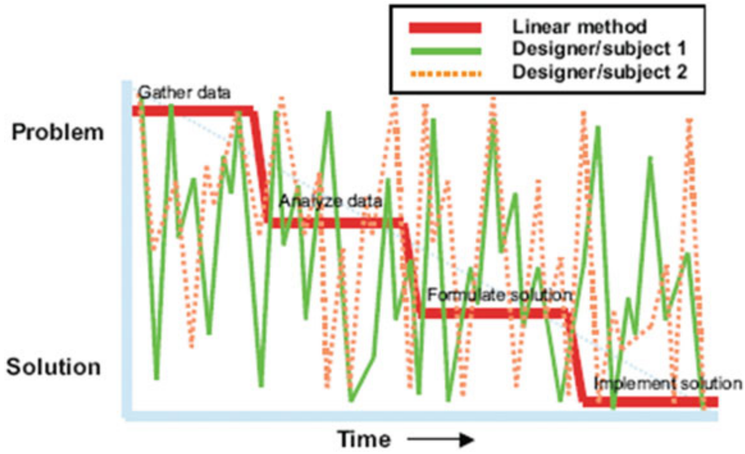

Fig. 3.3 A wicked project with a second designer working on the problem. (Conklin, 2006, p. 12)

Conklin (2006) summarises the problem to be faced as consisting of:

- Strong fragmenting forces of wicked problems, social complexity, combined with technical complexity.
- The confusion, chaos, and blame created by failing to distinguish these forces.
- The lack of tools and techniques for "defragmenting" project dynamics (or alternatively using the wrong tools to address the problem).

BUT Just when you thought that we knew everything there is to know about problems, another variant was identified to "spice" up the discussion. In 2007, Levin et al. (and 2012) came up with the addition of the "super wicked problem"!

Levin's original reference point was global climate change and they defined "super wicked problems" as having the following additional characteristics:

1. Time is running out.
2. No central authority.
3. ***Those seeking to solve the problem are also causing it.***
4. Policies discount the future irrationally.

I particularly like number 3 on the list—it is always us humans that mess things up!

I am sure that readers are able to come up with their own "super wicked problems" beyond that of just climate change—the situations in Afghanistan and Syria come to mind and the rest!

It is thus important to ask "Is your problem"

- A puzzle?
- A "causal" problem?
- "Wicked" or a "Mess"?

Or is it a problem with elements of "wickedness"?

3.2.3 Problems and the Uncertainty Profile

The table below allocates each of the problem types identified to the Uncertainty profile as presented earlier in Table 3.2 below.

3.3 Post Normal

Why have I included this as a topic? It is based on the link between **Wicked Problems and Systems Uncertainties.**

Post-normal science (PNS) represents a novel approach for the use of science on issues where *"facts are uncertain, values in dispute, stakes high and decisions urgent"*. Developed in the 1990s by Funtowicz and Ravetz (1994), drawing upon earlier dialogues between schools of thought developed by Popper (1959) and Kuhn (1962), which discussed the uses and abuses of the scientific method and its ability to address "uncertainties" and where the use of evidence is contested due to different norms and values.

Funtowicz and Ravetz focused on the quality of the scientific inputs to the policy process as being problematic with no-one willing to claim "truth" for his or her results, stating:

> Nor can uncertainty be banished, but good quality can be achieved by its proper management. The interaction of systems uncertainties and decision stakes can be used to provide guidance for the choice of appropriate problem solving strategies. When either of both are high, then mission-oriented applied science and client- serving professional consultancy are not adequate in themselves, and an issue-driven post-normal science is necessary. Just as in cases with ethical complexities (as in biomedical science) there must be an "extended peer community", including all stakeholders in the dialogue, for evaluating quality of scientific information in the policy process (Funtowicz & Ravetz, 1994, p. 1881). They go on to say that "systems uncertainties" can be interpreted as meaning a problem is less concerned with the;

Table 3.2 Matching problem type to the Uncertainty profile

	Identifiable/known	Unidentifiable/unknown
Predictable/ known	Q1. Known-known (I know what I know) Puzzle A problem	Q2. Known-unknown (I know what I do not know) A problem (with elements of wickedness)
Unpredictable/ unknown	Q3. Unknown-known (I do not know what I know or I think I know but turns out I do not) Wicked problem (and often a super wicked problem)	Q4. Unknown-unknown (I do not know what I do not know) Super wicked problem (but probably a Q3 issue)

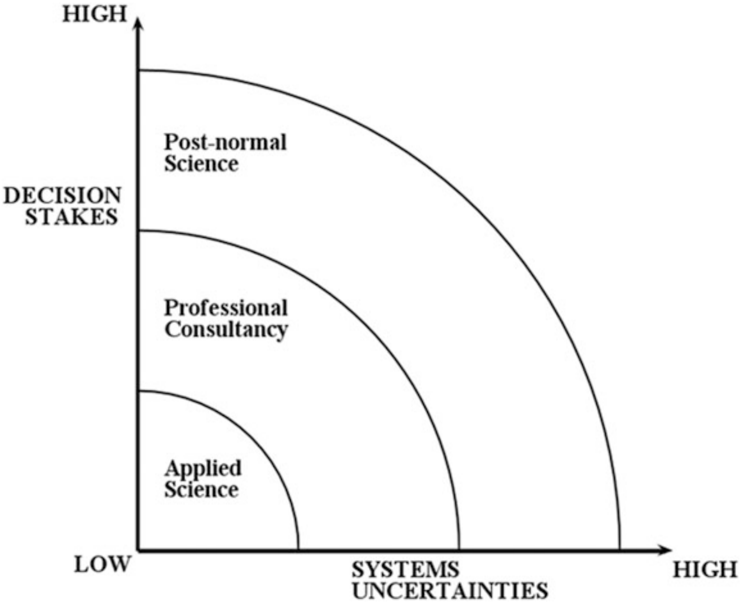

Fig. 3.4 Decision Stakes vs Systems Uncertainties (after Funtowicz and Ravetz)

> "discovery of a particular fact (as in traditional research), but with the comprehension or management of a reality that has irreducible complexities or uncertainties" (Funtowicz & Ravetz, 1994, p. 1882).

On the other hand, their term "decision stakes" refers to:

> all the various cost, benefits, and value commitments that are involved in the issue through the various stakeholders (Funtowicz & Ravetz, 1994, p. 1882).

The real commonality of the Funtowicz/Ravetz and the Rittel/Webber/Ackoff strands, is their plea against an over reliance on causal, usually quantitative, methods and their identification of the intangible and stakeholder-driven nature of numerous problems. It is important to drive home this difference between causal and non-causal approaches to problem identification. This standpoint acts as a warning against the over use of quantitative methods where dealing with the future and its inherent uncertainties—and to re-iterate Funtowicz and Ravetz's original proposition that *"facts are uncertain, values in dispute, stakes high and decisions urgent"*. Graphically the Funtowicz and Ravetz argument can be represented as in Fig. 3.4.

3.4 Methods, Tools, and Techniques (MMTs)

3.4.1 Problem Structuring Methods (PSMs)

PSMs have been developed to structure issues, problems, and decisions, rather than solving them. Prior to their development, it was seen that traditional Operational Research (OR) methods tended to restrict themselves to well-structured problems yielding finite answers which could be accurately monitored. In addition, traditional OR addressed systems which were complicated, often had a large number of parts. However, as identified via the Complexity and Interconnectivity section in Chap. 3, whilst such problems can be deemed to be complicated this does not imply that such systems have high complexity—the latter being a function of multiple information sources or inputs which are linked and interdependent and are often uncertain or intangible. In other words, there were a whole category of problems where traditional OR methods could not justify such a causal approach (Garvey, 2016; Garvey & Childs, 2013).

PSMs have a vital role in "mitigating" and formulating, rather than "solving" problems. They are especially suited in developing scenarios where behavioural factors impact perceived physical/causal considerations, particularly at the early stages of analysis, by reducing the number of "blind alleys" the analyst or decision maker may be induced to follow. Ormerod (2001) notes that the value of "soft OR", an alternative term used to accommodate PSMs, need not be judged solely on whether outcomes to the problem are successful or not, but that the processes carried out supported greater understanding, not necessarily resolution of higher complex problems. In response to a paper by Connell (2001), whereby a successful problem structuring exercise led to an apparently unsuccessful implementation, Ormerod argued that the use of PSM or soft OR processes allowed for greater understanding of highly complex problems particularly when key but varied stakeholders were engaged. The fact that implementation might be compromised due to a number of external factors (such as timing, budgets, engagement of teams not originally part of the initial programme) should not detract from the value provided initially by the PSM process—a process characterised by an acceptance of non-linearity as opposed to a linear approach to problem-solving—the latter methods often failing to understand the complexity generated by organisational and individual behaviours of participants within the problem space.

In the UK, Rosenhead and Mingers, leading exponents and academics, clustered a number of academic/practitioner generated methods under the title "Problem Structuring Methods (PSMs)". Their interpretation has tended to define the subject in fairly narrow terms based principally on British sourced methods such as:

- Soft Systems Methodology (SSM).
- Strategic Choice Approach (SCA).
- Strategic Options & Development Analysis (SODA).
- Robustness Analysis (RA).
- Drama Theory & Confrontation Analysis.

- Viable Systems Model (VSM).
- Systems Dynamics.
- Decision Analysis.

Other methods that could also be included but not addressed by Rosenhead and Mingers include "Rich Pictures", "Mind Mapping", and "Morphological Analysis", the latter two items being introduced in more detail in Chaps. 7 and 12.

Rosenhead and Mingers synthesise the function of PSMs as follows:

> (PSMs) provide a more radical response to the poor fit of the traditional OR approach for wicked problems. These conditions suggest that decision makers are more likely to use a method and find it helpful if it **accommodates multiple alternative perspectives, can facilitate negotiating a joint agenda, functions through interaction and iteration, and generates ownership of the problem formulation and its action implications through transparency of representation.** These social requirements in turn have various technical implications. Representing the problem complex graphically (rather than algebraically or in tables of numerical results) will aid participation. The existence of multiple perspectives invalidates the search for an optimum; the need is rather for systematic exploration of the solution space (author's bold font).

Rosenhead's substantive contribution is that he defines the nature of problematic situations for which PSMs aim to provide analytic assistance; in effect, he re-enforces those criteria identified by Rittel and Webber, Ackoff and Conklin, cited earlier, as being "wicked problems", and:

> in all cases, there is a meta-characteristic, that of complexity, arising out of the need to comprehend a tangle of issues without being able to start from a presumed consensual formulation.

Thus, in summary the situations referred to be Rosenhead are characterised as having:

- Multiple actors.
- Differing perspectives.
- Partially conflicting interests.
- Significant intangibles.
- Perplexing uncertainties.

In effect the same general characteristics as a "wicked problem".

As Rittel, Webber, and Conklin describe the converse "tame problems" so does Rosenhead compare PSM criteria with that of traditional Operational Research (OT) analysis:

- The client organisation is structured as a tight hierarchy.
- Few of its members are analytically sophisticated.
- The organisation or relevant unit performs a well-defined repetitive task generating reliable data.
- There is general consensus on priorities.

Rosenhead concludes that; *"in orthodox OR, the consultant is an analyst committed to extracting from perhaps recalcitrant data usable knowledge about the* *content of the problem confronting clients. When operating with PSMs, the consultant is a facilitator, attempting to manage the complexities and uncertainties of problem content while simultaneously managing the interpersonal processes and dynamic of the client group".*

The consultant role identified by Rosenhead is very similar to that expressed by Funtowicz and Ravetz (see Fig. 3.4 above), when describing the criteria of systems uncertainties. Ritchey (2006) also identified that many of Rosenhead's criteria apply to morphological analysis (MA) and thus should qualify as a PSM, albeit that the method is not specifically mentioned by Rosenhead. Ritchey reinforces the latter's argument about the role of facilitation along with there being additional criteria applicable to both established PSMs and MA, namely that such methods should be enhanced by being:

- Facilitated by a graphical (visual) representation for the systematic, group exploration of a solution space.
- Focusing on relationships between discrete alternatives rather than continuous variables.
- Concentrating on possibility rather than probability.

It is to be noted that Rosenhead also suggested that a wider acceptance and exploitation of PSMs is important if the potential of soft OR is to be realised in practice and that the unique characteristics of problem structuring in complex organisational settings require a holistic approach based not only on theory, but also practical and easy to use in the field. This view was corroborated by the author's own empirical action programme, where iterative methods helped to improve performance effectiveness and eradicated operational barriers to user understanding and uptake.

The criteria for describing the nature of a problem and its position in the decision-making process are extensive and can be used to qualify methods beyond those 8 methods presented by Rosenhead and Mingers. Such criteria are highly relevant to a much broader spectrum of problems than that originally postulated as being a PSM and can be expanded to embrace additional conditions such as volatility, interconnectivity, ambiguity, and complexity.

3.4.2 Robustness Analysis

One of the methods developed by Rosenhead is a hidden gem of a decision support method but has received insufficient attention and is called Robustness Analysis (RA)—not to be confused with Robust Decision-Making (RDM) as practiced by exponents at the Society of Decision Making under Deep Uncertainty (MDU) which is of more recent provenance (Marchau et al., 2019).

Traditional (linear) forms of operational research aim to eliminate uncertainty about the future through the identification of a single, preferred future and then plot a course towards this. Robustness analysis, on the other hand, embraces future uncertainty. Decisions made now are **robust** if they leave your options open. The method allows for the evaluation of initial decisions under conditions of uncertainty, but where subsequent decisions are likely to be introduced and implemented at some time in the future. The robustness amounts to the degree of flexibility which that initial decision or commitment allows for in future decision choice. This relationship is expressed as a ratio of the total number of acceptable options at a particular pint in the future or even multi-futures. In essence robustness provides options as to the relative flexibility of alternatives—leaving your options open.

Marsh (2011) offers an example of the use of robustness analysis within the domain of a military research programme such that:

> Decisions are made now about the research programme for the next few years. A decision might be to research further into robotic vision, or build a demonstrator of a robot able to move itself across rough ground. Products are planned, ultimate results of the research, e.g. new equipment or improvements in current equipment. Given the uncertainty of research, and of later procurement decisions, these products might or might not get implemented. Scenarios represent circumstances when the products will be of use. A single scenario is only one part of a 'possible future', since more than of them may 'occur' in the timeframe of interest.

Marsh states that the value of a product in a scenario can be expressed in terms of how well the products help the military achieve their objectives. Being a judgemental technique, Robustness Analysis is best suited to identifying "fuzzy" or coarse scale outcomes such as high, medium low, or not applicable.

3.4.3 Rosenhead's Summary

Rosenhead's own description of the method (apart from the more detailed descriptions and process in Chap. 8 of the 2001 book "Rational Analysis for a Problematic World Revisited) was best summarised in a EWG-MCDA Newsletter dated Autumn 2002. An edited version is presented in Appendix 1.

3.5 Summary

This chapter has introduced to the reader that problems come in various shapes and sizes. Once the problem characteristic has been identified (is it a puzzle or a wicked problem?), then the problem can be positioned within the Uncertainty matrix so the correct PSM can be applied. The chapter ends by introducing Rosenhead's Robustness Analysis method as an appropriate MTT for addressing the early stages of problem identification.

References

Ackoff, R. (1961). *Progress in operations research*. Wiley.

Ackoff, R. L. (1974). *Redesigning the future*. Wiley-Interscience.

Beer, S. (1984). The viable system model: Its provenance, development, methodology and pathology. *Journal of the Operational Research Society, 35*, 7–26.

Conklin, J. (2006). *Dialogue mapping: Building shared understanding of wicked problems*. Wiley.

Connell, N. (2001). Evaluating soft OR: Some reflections on an apparently "unsuccessful" implementation using Soft Systems Methodology (SSM).

Funtowicz, S. O., & Ravetz, J. R. (May 1994). Uncertainty, complexity and post-normal science. In *The annual review of environmental toxicology and chemistry*, Vol 13, No 12. Pergamon.

Garvey, B. (October 2016). *Combining qualitative and qualitative aspects of problem structuring in computational morphological analysis*. PhD thesis. Dyson School of Design Engineering, Imperial College London.

Garvey, B., & Childs, P. R. N. (2013). Applying problem structuring methods to the design process for safety helmets. *Proceedings of the 1st International Conference on Helmet Performance and Design, London*, February 15, 2013.

Grint, K. (1997). *Fuzzy management: Contemporary ideas and practices at work*. Oxford University Press.

Kuhn, T. (1962). *The structure of scientific revolutions*. University of Chicago Press.

Kunz, W., & Rittel, H. (1970). Issues as elements of information systems. Working Paper No. 131, Heidelberg-Berkeley.

Levin, K., Cashore, B., Auld, G., & Bernstein, S. (2012). Introduced the distinction between "wicked problems" and "super wicked problems" in a 2007 conference paper, followed by a 2012 journal article in *Policy Sciences*. Problems.

Marchau, A., Walker, W., Bloeman, & Popper, S. (Eds.). (2019). *Decision making under deep uncertainty, Chapters 2, 7*. Springer.

Marsh, D. (2011). *A robust approach to military research programme planning*. Smith System Engineering Ltd.

Nelson, R. R. (1974). Intellectualizing about the Moon-Ghetto Metaphor. *Policy Sciences*, 5, 375–414. Elsevier Scientific Publishing, Amsterdam.

Ormerod, R. (2001). Viewpoint: The success and failure of methodologies – A comment on Connell (2001): Evaluating soft OR. *The Journal of Operational Research Society*, Palgrave, October 2001.

Pidd, M. (1996). *Tools for thinking* (p. 40). Wiley.

Popper, K. (1959). *The logic of scientific discovery*. Springer and Hutchinson.

Ritchey, T. (2002). *Modelling complex socio-technical systems using morphological analysis*. Adapted from address to the Swedish Parliamentary IT Commission, Stockholm, December 2002.

Ritchey, T. (2006). Problem structuring using computer-aided morphological analysis. Published by *Journal of the Operational Research Society*, *57*.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, Vol. 4, pp 155–169. Elsevier Scientific Publishing Company: Amsterdam.

Rosenhead, J., & Mingers, J. (2001). *A new paradigm of analysis in rational analysis for a problematic world revisited* (2nd ed.). Wiley.

Simon, A. H. (1977). *The new science of management decision*. Prentice-Hall.

Treverton, G. (2010). Addressing complexities in homeland security. In L. K. Johnson (Ed.), *The Oxford handbook of national security intelligence*. Oxford University Press.